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tral nervous system from the labyrinth." Crum Brown's statement of the function of the semicircular canals was "the perception of the change of aspect of the head in space." This statement has stood the test of criticism and one usually is aware of the change of aspect of the head in space.

The easy-going husband and the nagging wife find their counterpart in the ventricles and the auricles of the heart, p. 257. A declaration of independence on the part of either husband or ventricle leads to domestic infelicity.

On the whole, the book fulfills its particular purpose better than any other with which I am familiar. Writing such a book is a particularly difficult task, and the author has succeeded better than most. There are many new diagrams of unusual clearness.

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GOODALE'S EXPERIMENTS ON GONADECTOMY OF FOWLS

It has long been known that the removal of the testes of the male fowl does not affect materially the complete development of the secondary sexual characters of the cock, although a critical examination of the results has been much needed. The change of the hen's plumage into that of the cock, a change that occasionally takes place in old age, or when the ovary has become diseased, is also a matter of record, but the evidence for this has been rather anecdotal than detailed. Both changes have now been carefully studied by Goodale in a series of carefully planned experiments carried out through a series of years, mainly at the Station for Experimental Evolution of the Carnegie Institution. The results¹ have been published recently by the Carnegie Institution. The excellent colored drawings that illustrate the results greatly enhance their value.

¹ "Gonadectomy in Relation to Secondary Sexual Characters of Some Domestic Birds," H. D. Goodale, Carnegie Institution of Washington, 1916, No. 243.

The operation was made on Rouen ducks as well as on fowls (Brown Leghorns) and the results are in agreement in all essential respects. Complete removal of the testes either from very young, or even from older birds, does not cause any lessening of secondary sexual plumage, although in a few points the capon differs in plumage slightly from the normal cock and in a few minor points also other than plumage. The complete removal of the ovary of the birds is an extremely difficult operation and is rarely entirely successful. Failure to remove all of the tissue gives an opportunity for regeneration of the gland, which completely nullifies the attempted experiment. When removal of the ovary was complete (as shown by subsequent dissection) the duck and hen assumed the male plumage. When the very great differences in the plumage of the Brown Leghorn hen and cock and of the Rouen duck and drake are recalled, the change is startling; for it involves not only the transformation of the brown plumage of the hen into the brilliant red and black of the cock, but involves likewise a change in the shape of many of the feathers, notably those of the hackle, back, saddle and shoulder as well as minute details in the barbules. Goodale exhibited such a cock-feathered hen at the Christmas meeting of the Naturalists, as well as one case in which the testes had been removed from a young cock and an ovary engrafted in their place. The presence of the latter had prevented the cock, when adult, from developing the characteristic male plumage. He resembled a hen in essentially all plumage characters.

Into the details of the work it is not possible to enter here—details that involve the effect of incomplete gonadectomy, the possible influence of other organs in the neighborhood of the gonad, the relation between the juvenile plumage and that of the adult female, and in the case of the ducks the effect of gonadectomy on the nuptial and eclipse plumage. Several results here obtained are entirely new and a number of problems raised heretofore unsuspected.

The comb of the capon fails to reach the full development of that characteristic of the Brown Leghorn cock, while in the spayed female the comb becomes male-like in certain individuals at least. The spurs develop on the capon as well as on the cock—a result that shows that this secondary sexual character at least is little if at all affected by the removal of the testes. In the Brown Leghorn hen and more commonly in other breeds, spurs may occur on the female occasionally, and even be developed as completely as in the male, but they developed *in all* the successfully spayed females. In the light of the occasional occurrence of spur in the female, the results after spaying can not be definitely ascribed to the absence of the ovary, although this is the more probable conclusion.

In castrated drakes and in spayed ducks the voice remains normal “except that some castrated females occasionally give voice to a sound similar to the drake’s.” In fowls, on the other hand, both sexes after gonadectomy “are disinclined to give voice,” although capons may give all the sounds characteristic of clarion (but rarely do so). The spayed females were not observed to crow.

At the time when Goodale’s paper was written the effect of castration on hen-feathered males (that are characteristic of certain races, notably Sebrights, Hamburgs and Campines) was not known. Since then the reviewer has shown that not only the F_1 (dominant) and F_2 hen-feathered males assume the full plumage of the cock, but that this holds true for the pure Sebright cock also.

Goodale discusses the nature of the influence that brings about the change after removal of the ovary and concludes that the ovary secretes some substance that holds in check the development of full male characters that may be assumed to be inherited through *both* sexes. A parallel case is furnished by the experiments referred to above, in crosses of Sebrights and Black Breasted Game Bantams, that show that hen feathering is transmitted as a non-sex-linked character both by the hen and by the cock. Cock

feathering develops in the hen-feathered cock after castration, as well as in the hen when old (according to a brief notice by Darwin in “Animals and Plants,” Chapter XIII., Vol. 11, p. 29). The probable nature of such an internal secretion is discussed by Goodale in the following significant statement (page 49):

The adjustment of the ovarian secretion to the characters it modifies is very close, as shown by the fact that the male characters produced in a given female are like those of the corresponding male. . . . From this we may conclude that the secretion on the whole is relatively simple and probably of uniform nature. If the secretion were composed of many substances, one to produce each effect involved, such as the change from a vermiculated feather to penciled, from a gray and white to a black and brown, the resulting complexity would be so great that one would not anticipate any such close coordination as actually results. For purposes of illustration we may assume that the ovarian secretion is simple, producing its effect by oxidation or some other simple process. The sort of result produced by oxidation, of course, depends upon the substance that is oxidized.

It need scarcely be added that this statement furnishes no grounds for the identification of the enzyme produced in the testes with the factor or factors that represent it in the sex chromosome, viz., the sex-determining factors. It is possible, of course, that the sex factors are enzymes, but there is not the slightest warrant for drawing the conclusion that they are (as some recent writers have done) from genetic evidence of this kind, for it is also possible that there may be a long series of reactions between the chemical substance in the chromosome that we may identify if it pleases us to do so as the genetic factor, and the enzyme that develops later when the testes are formed.

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SPECIAL ARTICLES

THE BEHAVIOR OF CERTAIN GELS USEFUL IN THE INTERPRETATION OF THE ACTION OF PLANTS

THE amorphous carbohydrates constitute a very important part of the colloids of the